
Space Weather Technical Forecast

Issued on Tuesday 8 October 2024 at 13:29 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1-G2 Minor/Moderate Storms easing day 1. Chance of further X-class flares. Chance of S1 Minor Solar Radiation Storm.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: High with peak flare X2.1 from AR3842 at 07/1913 UTC. This occurred simultaneously with a long period flare from just over the southwest limb, that peaked X1.0 at 07/2059 UTC, likely associated with AR3844. These are the most active regions of a collection of sunspots on the southwest limb that are becoming harder to assess, but remain likely flare sources given the associated bright magnetic looping evident on SDO aia imagery. There are seven regions in total on the disc, with other regions of note including the large, mature but inactive AR3848 in the north-centre disc and AR3849 and AR3850 in the southeast, although these have also remained inactive.

The X2.1 and X1.0 flares produced two CMEs, the first directed south and west of Earth, with the second on the limb. Analysis has resulted in both CMEs missing Earth, but with a slight chance of a glancing impact from the X2.1 flare associated CME. A large filament eruption was also seen to leave the Sun early on 08 Oct, it appears to be directed mainly south, though further analysis is necessary before a conclusion can be made of an Earth-directed component.

Solar Wind / Geomagnetic Activity: Multiple weak CME enhancements were possible in this period, perhaps including the glancing influence of the 04 Oct CME, however nothing definitive was identifiable. The onset of any fast wind from CH78 also potentially occurred. Solar wind speed remained slightly elevated, between 400-470km/s, with density varying between below average and average values. Interplanetary Magnetic Field, Bt, was largely Moderate, between 8nT and 16nT. The north-south component, Bz, favoured a negative (southward) orientation with only brief spells of positive (northward), and also varied between Weak and Moderate levels, ranging from -16nT to +3nT. Phi angle was negative (towards the Sun), then rotated to be positive (away from the Sun) by 07/1900 UTC. Geomagnetic activity was mainly at G1-G2/Minor-Moderate Storm, with a two G3-Strong Storm intervals between 080000-0600 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background for much of the period, but rose erratically in response to the X-flares from 07/2325 UTC. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate (at diurnal peak). The associated 24-hour fluence was below the Active threshold with 1.93e6 observed at 08/0000UTC.

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Four-Day Space Weather Forecast Summary

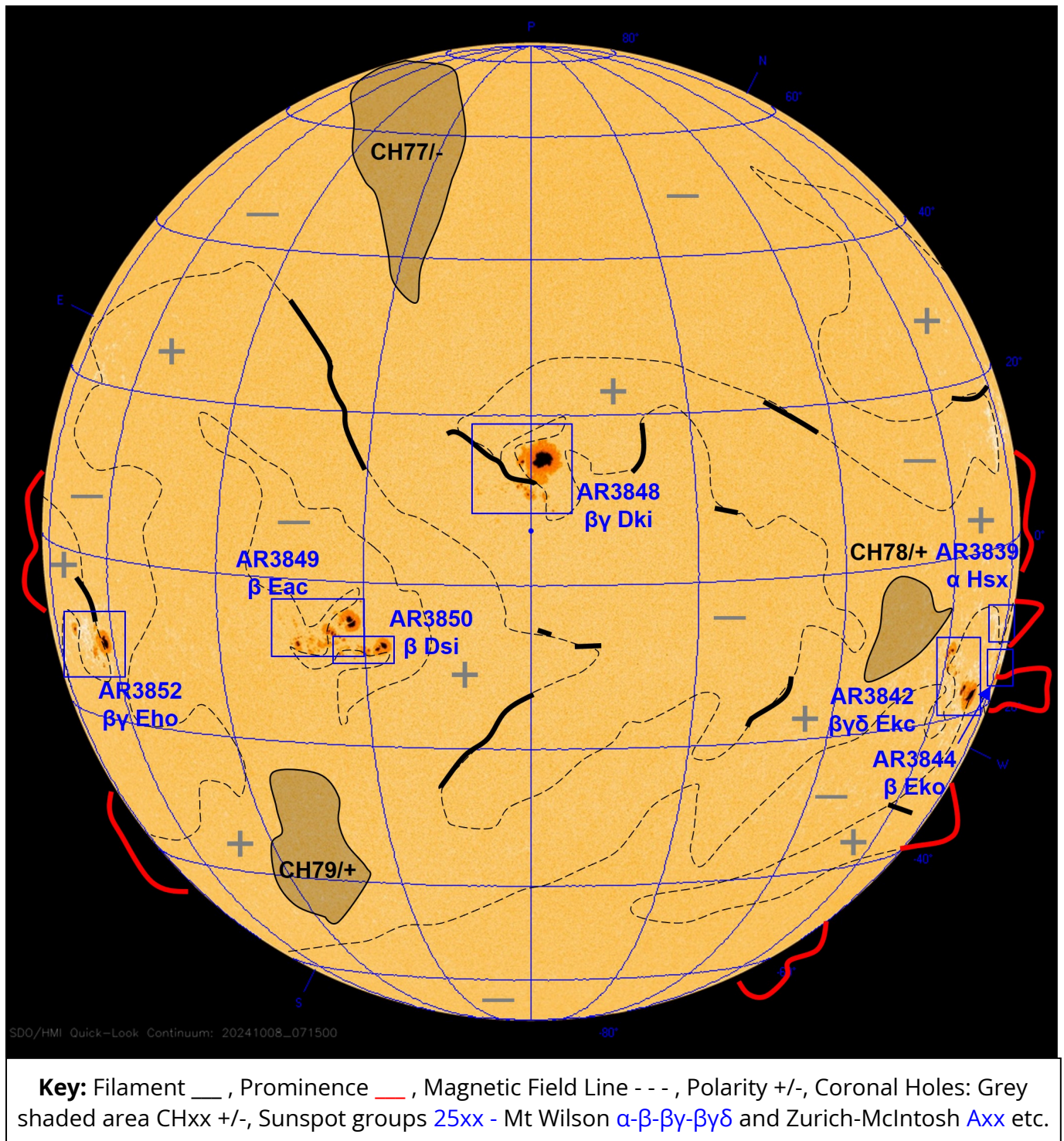
Solar Activity: High to Moderate activity is expected, with a chance of further X-class flares until day 3 (10 Oct). Activity then easing to be Low to Moderate but with a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: No further Earth-directed CMEs currently feature in the forecast. However there are up to two glancing CMEs possible later in the period. The solar wind environment around Earth remains disturbed at first, due to ongoing CME influences and coronal hole fast winds from CH78/+. Solar wind speeds are likely to ease, with a slight chance of becoming slightly enhanced or enhanced for a time days 3 or 4 should any glancing CME impacts occur.

G1-G2 Minor to Moderate storms, with a slight chance of an isolated G3 Strong storm interval at first. However this risk will recede into day 2, with activity becoming Quiet to Active with a chance of G1 Minor Storms. Quiet to Unsettled conditions are then expected from day 3 (10 Oct), however any CME glancing impacts will bring a chance of further G1-G2 Minor to Moderate storms.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 responded erratically to the two X class flares from late on 07 Oct, with proton levels remaining below the S1 Minor radiation storm level. There is a chance of a delayed or slow increase of proton flux in coming days with a chance of reaching S1 proton levels later day 1 or perhaps day 2 (Oct 08 or 09). High energy electron flux is also expected to gradually rise through the period, albeit with the typical diurnal oscillation, with the associated 24 hour election fluence responding likewise. This will bring a chance of reaching the Active threshold (1e8 total pfu) by the end of day 3 (10 Oct).

Figure 1: Solar synoptic map valid 08/0715 UTC.



Geomagnetic Storms

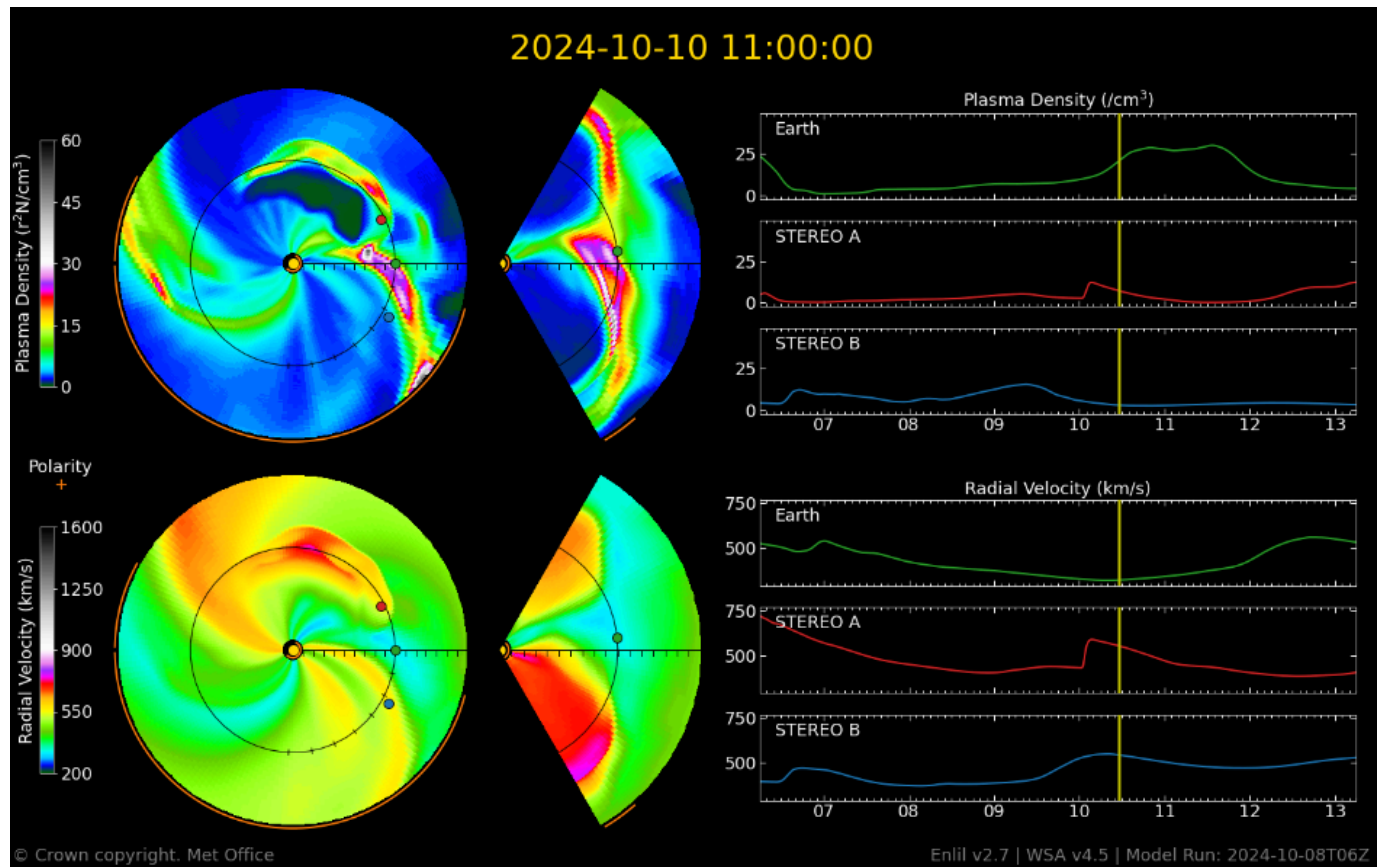
No further Earth-directed CMEs currently feature in the forecast. However the large and bright CMEs evident from the X2.1 and X1.0 flares are expected to miss Earth but may have an outside chance of glancing impacts, perhaps on day 3 or day 4 (10 or 11 Oct). A large filament eruption was also seen to leave the Sun early on 08 Oct, it appears to be directed mainly south, though further analysis is necessary before a conclusion can be made of an Earth-directed component.

The solar wind environment around Earth remains disturbed at first, due to ongoing CME influences and coronal hole fast winds from CH78/+. Solar wind speeds are likely to remain slightly elevated or barring any CME enhancements fall back to slow-ambient speeds within the next 4 days. This is low confidence however, with Enlil not featuring this enhancement. Should any CME glancing interactions occur on days 3 or 4 (10-11 Oct) solar wind speeds may become slightly enhanced or enhanced for for a time.

G1-G2 Minor to Moderate storms, with a slight chance of an isolated G3 Strong storm interval at first. However this risk will recede into day 2, with activity becoming Quiet to Active with a chance of G1 Minor Storms. Quiet to Unsettled conditions are then expected from day 3 (10 Oct), however any CME glancing impacts will bring a chance of further G1-G2 Minor to Moderate storms.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	70	30	20	20
Strong	G3	Yes	20	5	2	2
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



Radio Blackouts - X-Ray Flares

Activity is currently High, with an X2.1 flare observed from AR3842 peaking at 07/1913 UTC. This was followed by a very long period M-flare, which slowly built back to just reach X1.0 peaking 07/2059 UTC, and was likely from AR3844 on the west limb. The combined flaring of these two regions only gradually declined and fell below M-class at 08/02113 UTC.

There are seven sunspot regions visible. However three of these regions, including the larger AR3844 and AR3842 are becoming harder to assess as they transit around the west limb. AR3842 was the source of the X7 and X9 flares in recent days, but had been relatively quiet with little development until the X2.1 at 07/1913 UTC. SDO imagery continues to show bright magnetic looping in the corona above both of these spots, and with a strong delta spot persisting in AR3842, further flares are likely. There are other notable regions on the disc as well, although these have remained benign so far. AR3848 in the north-centre has a very large mature positive leader, but has shown little sign of dynamical changes and remains relatively simple with only weak negative spots to its south. AR3849 and AR3850 are two smaller, close proximity regions, comprised of a number of smaller spots. AR3852 is now moving into a clearer view, but appears relatively open and simple.

Given the bright looping above these regions in SDO imagery, alongside the other regions on the disc, further M-flares are expected, with on ongoing chance of a further isolated X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	70
Very Active	R3-R5 (X Class)	Yes	30	30	30	20

Figure 3: 24 X-ray trace showing X2 and X1 flares from near AR3842.



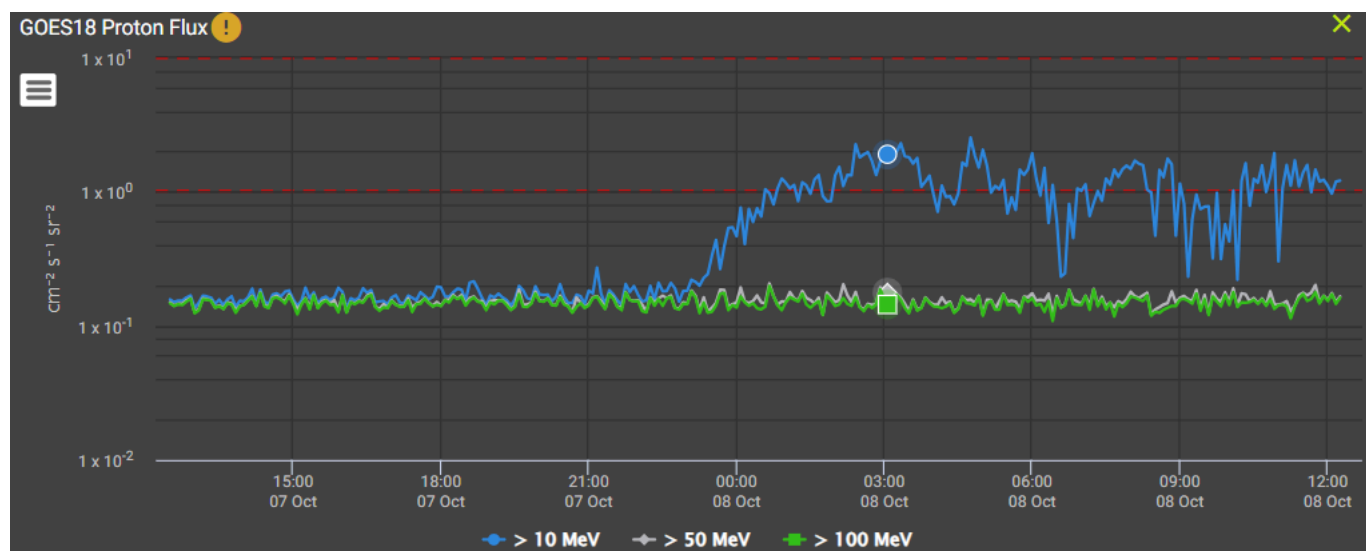
Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 responded erratically to the X2.1 and X1.0 flares that occurred late on 07 Oct, with proton levels remaining below the S1 Minor radiation storm level. There is a chance of a delayed or slow increase of proton flux in coming days with a chance of reaching S1 proton levels later day 1 or perhaps day 2 (Oct 08 or 09).

Further flares from these regions will also bring an increased chance of seeing proton flux rise at GEO, although this risk recedes later day 3 and day 4 (10-11 Oct) as AR3842 retreats onto the far-side, with the other regions on the disc currently relatively inactive.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	40	40	20	10
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

Figure 4: 24 hour proton trace



High Energy Electrons ($\geq 2\text{MeV}$)

High energy electron flux (greater than 2MeV) observed by GOES16 was at background, likely suppressed due to ongoing solar wind enhancements from the CME and coronal hole fast winds from CH78/+. These have likely increase electron populations at lower orbits however, and as solar wind pressure subsides and the Van Allen belts return outward, flux is expected to rise at GEO. This likely giving Moderate, perhaps diurnally High values by day 3 (10 Oct) onward.

The associated 24 hour fluence is expected to persist below the Active threshold, but with a rising trend later in the period, bringing a chance of reaching the Active ($1\text{e}8$ total pfu) level by the end of day 3 (10 Oct). This rising trend is supported by REFM, however this is likely underplaying the expected values by the end of the period.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	25	30
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: Moswoc REFM and electron flux.

